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CONTROLLING STATIC ELECTRICITY ON COTTON DURING GINNING WITH AN ANTISTATIC AGENT

Agricultural Research Service
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CONTROLLING STATIC ELECTRICITY ON COTTON DURING GINNING WITH AN ANTISTATIC AGENT

By Clarence G. Leonard [1]

INTRODUCTION

Static electricity can be a serious problem to cotton ginners when the cotton is extremely dry during ginning, particularly in cold weather. Research on static control at gins was initiated at the Southwestern Cotton Ginning Research Laboratory, Mesilla Park, N. Mex., in 1950. Since then several phases of the problem have been investigated.[2] This report deals with control by means of antistatic solutions. At saw gins it is sprayed on seed cotton as it enters the ginning system; with roller gins the chemical solution is painted on the rollers with a brush.

Electric charges are generated on dry fibers by the rapid movement of the cotton through the piping and machinery during ginning. If the electric conductivity of the cotton is low, the charges will accumulate on it. Buildup of electric charges on cotton induces electric charges of opposite polarity on closeby metal surfaces; and the two sets of charges, those on the cotton and the induced ones, exert an attractive force on each other. If the force of attraction becomes strong enough at any location to counterbalance the forces tending to transport the cotton through the system, the cotton sticks to and collects on the nearest surface, causing a potential stoppage.

One method of eliminating the occurrence of chockage due to static electricity is to increase the electric conductivity of the cotton fibers. Then electric charges, whenever generated, will rapidly flow off to the first metal surface the cotton touches, thus eliminating static charge buildup on the cotton. The primary function of an antistatic agent is to increase the electric conductivity of the surface of the material to which it is applied.

1/ Physicist, Agricultural Engineering Research Division, ARS, USDA, located at the Southwestern Cotton Ginning Research Laboratory, Mesilla Park, N. Mex.

2/ Leonard, Clarence G., and Stedronsky, Victor L., "Effects of Electrical Bonding and Grounding on Static Generation in Cotton Gins" U. S. Dept. of Agri. Cir. 949, October 1954.
Leonard, Clarence G., "Static, No Match for Matches." The Cotton Gin and Oil Mill Press, 56 (19): 24, 32. 1955.

During the 1955 and 1956 crop seasons, several salts and liquids were used in ginning tests at the Southwestern Cotton Ginning Research Laboratory to determine:

1. Effectiveness as an antistatic agent on cotton.
2. Practicability for use at cotton gins.
3. Effects on cleaning and ginning characteristics, fiber qualities, and mill processing of cotton.

Some of these materials gave promising results, and two liquids, Avcosol-20 and Tween-20, were selected for laboratory tests in saw and roller ginning.[3/] They were similar in physical and antistatic properties, but it developed that Avcosol-20 was not readily available in the desired quantities for trials in commercial gins and Tween-20 was used in subsequent work.[4/] Tween-20 is a nonionic liquid readily soluble in water, and it will tolerate a high degree of hardness. It can be stored for long periods of time either pure or in water solutions.

SAW GINNING

Laboratory Evaluations

Equipment and Procedures The Laboratory evaluation ginning test with Avcosol-20 was made in January 1957 with hand-picked Acala 1517 seed cotton grown on the New Mexico State University Agronomy Farm in the previous season. The cotton was stored loose indoors from the time of picking until the test. The test consisted of two treatments replicated three times. Each replication was made on a different day. Each test lot weighed 225 pounds (seed cotton) and was identically processed (fig. 1) except for the treatment differences described.

The first treatment was a control spray of water to which nothing was added; in the other treatment a solution of antistatic agent and tapwater was sprayed on the seed cotton in the suction pickup pipe. The location of the suction pickup pipe in the laboratory test corresponded to the wagon suction pipe in commercial ginning operations. Following each lot to which the antistatic agent was applied, 2 cleanout lots of 225 pounds of seed cotton were run to remove any residue from the machinery and piping.

3/ Mention of trade products in this publication does not imply their endorsement by the Department of Agriculture over similar products not named.

4/ Avcosol-20 was formerly marketed by the American Viscose Corporation and the Tween-20 used was manufactured and marketed by the Atlas Powder Company, Wilmington, Del.

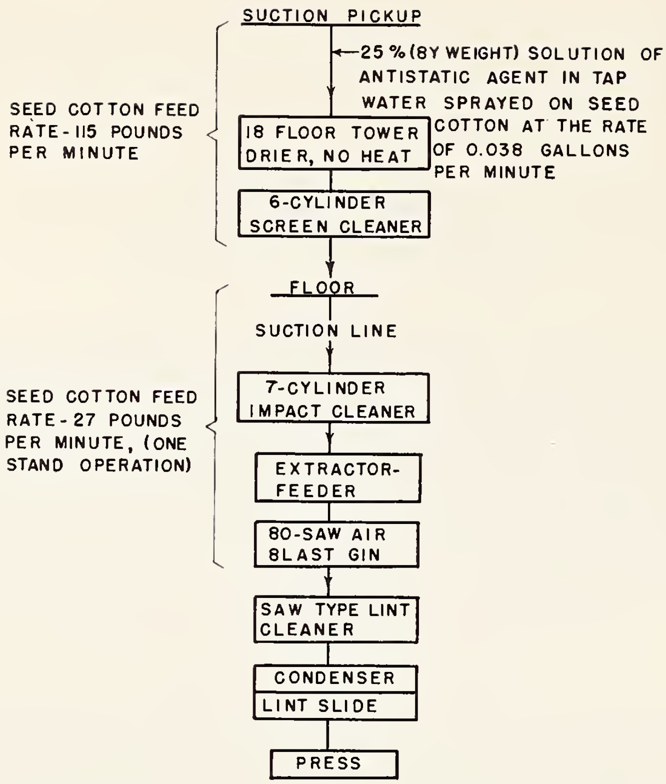

Figure 1. Equipment setup employed for testing the use of an antistatic agent for controlling static electricity during ginning.

The solution used to treat the cotton was of 25 percent concentration (by weight) of antistatic agent in tapwater. This was applied as a spray by using a pressure-tank system (fig. 2) with a Spraying Systems Company "Tee-Jet" flat spray nozzle (No. 1/4/ T 650033) with a pressure of 42 p.s.i. The nozzle was mounted on a rectangular section of vertical piping installed in the 12-inch diameter suction pickup line. A deflection plate was mounted just downstream from the nozzle opening to deflect the seed cotton away from the nozzle. The spray equipment was adjusted to supply 0.2 percent antistatic agent to the seed cotton based on lint weight. This was equivalent to adding 1 pound of agent to a 500--pound bale of lint. Because some of the agent will be lost to trash, the actual amount remaining on the lint will always be less than the amount applied to the cotton.

The agent-to-water ratio necessary to apply a given amount of antistatic agent per unit weight of cotton is determined by the average rate of flow of cotton past the point of application and the spray rate capacity of the nozzle used. The water assists in spreading the anti-

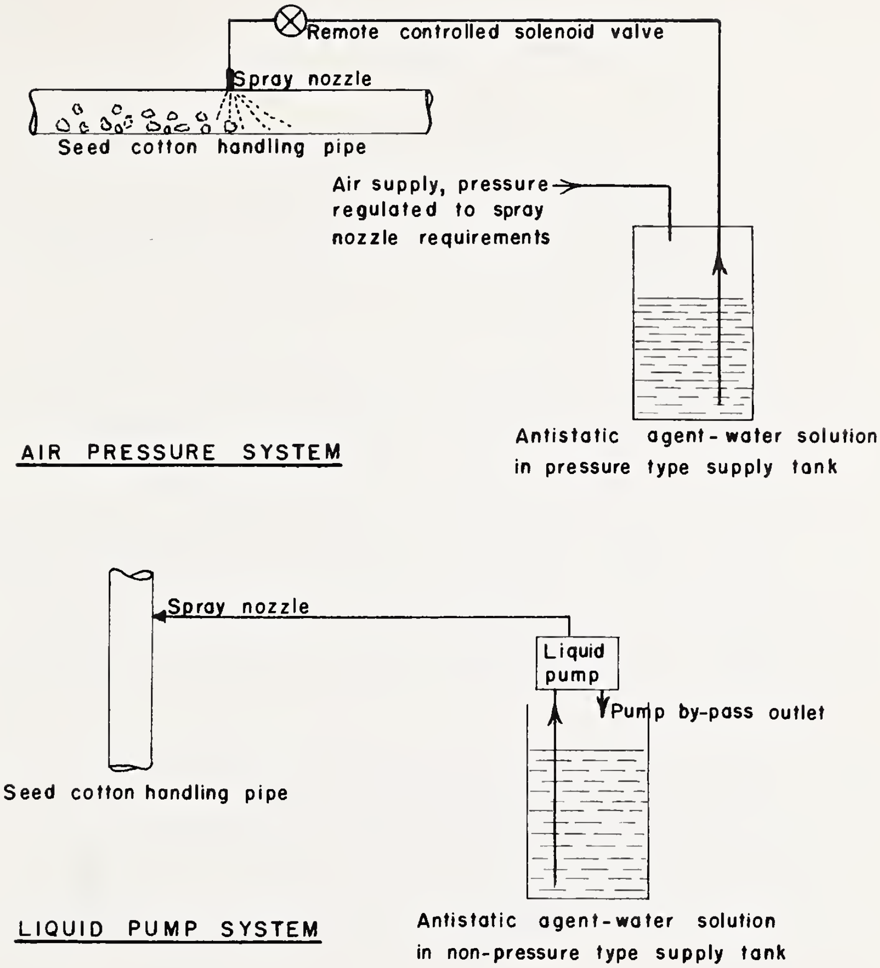

Figure 2. Schematic drawings of spraying systems suitable for applying an antistatic agent to seed cotton to control static electricity during ginning.

static agent on the cotton, and any increase in fiber moisture that water produces, also tends to decrease the static. The use of weak concentrations requiring high water spray rates may cause difficulties, particularly when applied to cottons containing large percentages of foreign matter.

Samples of seed cotton were taken at the wagon and feeder apron from each lot for foreign matter and moisture content determinations. Samples of ginned lint were taken from each lot for moisture and nonlint determinations, classification, fiber analysis, and small scale spinning and chemical-finishing tests. Static intensities on the cotton were measured by electronic instrumentation (recording vacuum voltmeter; pickup probes for this instrument located in lint flue and at lint-slide

condenser outlet), and by visual inspection at the feeder apron, lint cleaner inlet, lint condenser, and lint slide. The temperature of the conveying air was measured at several locations, and the temperature and relative humidity of the gin-room air were recorded.

Effectiveness of Antistatic Agent Application of the antistatic agent at the rate of 0.2 percent of the lint weight eliminated visual evidence of static and reduced instrumental indications to low intensity. On the control lots of replications A and B (table 1) the static was very intense at the condenser and lint slide but was just noticeable visually on the control lot of replication C.

The continuous recordings of the static intensity showed that minimum static was achieved not during the processing of the treated lots but during the first part of the first cleanout lots, indicating a residual effect. Based on this information, the spray equipment was later set to apply the agent at the rate of 0.1 percent addition by lint weight to the seed cotton, and several lots of cotton were run with and without the antistatic agent. This lower rate equivalent to one-half pound of agent per bale, controlled static just as effectively under the conditions in which it was tried as the higher rate (0.2 percent addition). These laboratory tests at the lower rate were informal, and cotton samples were not taken for quality evaluation.

Table 1 gives the results of the measurements of the gin-room atmosphere, cotton moisture, and foreign matter contents, and the visual observations of the effects due to static electricity. The only statistically significant changes that occurred were in static intensities. The decrease in static intensity of the control lot of replication C was probably associated with the small increase in average gin-room air relative humidity. The cotton was stored loose on the gin-room floor until used.

There were slight increases in nonlint contents (table 2) of the samples receiving the antistatic agent; however, the Government classer's grade designation was Good Middling for all lots. Staple length and color determinations showed no significant differences between samples receiving and not receiving the antistatic agent.

Fiber Analysis Results Two sets of lint samples were taken for fiber analysis to determine whether the antistatic agent affected fiber quality and also to measure any changes the agent might cause to lint in storage. One set of samples was tested 3 weeks after the ginning test, and the second was tested 11 weeks after the test. There were no significant changes in fiber properties owing to either the

Table 1. Results of measurements relating to the ginning of cotton treated and not treated with an antistatic agent (Avcosol-20) to reduce static electricity on cotton during ginning

Treatment 1/	Replication	Date ginned	Gin room atmosphere 2/ Temperature	Gin room atmosphere 2/ Relative humidity	Moisture contents, Seed cotton, Wagon sample	Moisture contents, Seed cotton, Feeder sample	Moisture contents, Lint sample	Visual static at the lint slide 3/	Foreign matter in seed cotton, Wagon sample	Foreign matter in seed cotton, Feeder sample
			^{o}F.	pct.	pct.	pct.	pct.	Rating	pct.	pct.
Control	A	1-17-57	55 ± 8	26 ± 3	5.2	5.4	4.17	5	4.7	0.7
	B	1-18-57	52 ± 4	25 ± 3	5.3	5.5	4.10	5	3.6	.6
	C	1-21-57	55 ± 4	29 ± 4	5.6	5.7	4.40	1	4.4	.7
Average					5.4	5.5	4.22	3.7	4.2	.7
Treated, 0.2 pct. Avcosol-20 added to seed cotton (based on lint weight)	A	1-17-57	55 ± 8	26 ± 3	5.2	5.4	4.18	0	3.3	.7
	B	1-18-57	52 ± 4	25 ± 3	5.4	5.6	4.63	0	4.4	.7
	C	1-21-57	55 ± 4	29 ± 4	5.8	5.3	4.52	0	3.9	.8
Average					5.5	5.4	4.44	0	3.9	.7

1/ All lots were handled through a tower drier (no heat), 13 cylinders of cleaning, extractor feeder, 80-saw gin, and saw-type lint cleaner.

2/ Average of test period and previous 8 hours, measured and recorded with a hygrothermograph.

3/ Arbitrary relative scale: 0-No detectable static; 1-noticeable; 2-light; 3-medium; 4-heavy; 5-extremely heavy.

Table 2. Effects on some lint characteristics of the application of an antistatic agent (Avcosol-20) to cotton to control static electricity during ginning[1/]

Measurement	Control[2/]	Treated[2/]
Lint sampled from lint slide:		
Nonlint content . . . . . . percent . . .	2.15	2.57
Classification:		
Grade . . . . designation . . .	Good Middling	Good Middling
Staple length . . . . inches . .	1-1/8	1-1/8
Color:[3/]		
Reflectance . . . . Rd .	81.3	81.3
Yellowness . . . . +b	7.9	8.0

1/ Measurements from 3 replications.

2/ All lots were handled through a tower drier (no heat), 13 cylinders of cleaning, extractor feeder, 80-saw gin, and saw-type lint cleaner. The control lots received no other treatment while 0.2 percent antistatic agent (based on lint weight) was applied to the seed cotton in the treated lots.

3/ Color measured with a Nickerson-Hunter Cotton Colorimeter after sample was cleaned in a Shirley Analyzer.

antistatic agent and 3 weeks' storage or the agent plus storage for 11 weeks (table 3).

Lint samples taken from two replications of the test were sent to the Clemson Cotton Laboratory[5/], Clemson, South Carolina, where spinning and chemical-finishing measurements were made. The results of these measurements are given in table 4. No statistically significant differences resulted from the treatments.

5/ One of the Laboratories of the Standards and Testing Branch, Cotton Division, Agricultural Marketing Service, U. S. Department of Agriculture.

Table 3. Effects of an antistatic agent (Avcosol-20) applied to cotton during ginning on the fiber properties of lint after 2 periods of sample storage.1/

Measurement	Tested after 3 weeks storage		Tested after 11 weeks storage	
	Control2/	Treated2/	Control2/	Treated2/
Fiber length (Fibrograph):				
Upper half mean . . . . inches	1.13	1.14	1.14	1.14
Mean . . . . inches	0.89	0.89	0.90	0.90
Uniformity . . . . .ratio	79	81	79	79
Fiber tensile strength (Pressley):				
1/8-inch gage . . . . index	115	115	111	112
Fiber fineness and maturity:				
Fineness (Causticaire) . . . . µg. /inch	3.6	3.7	3.6	3.7
Maturity (Causticaire) . . . . index	75	75	76	76
Sugar content . . . . percent	0.3	0.3	0.4	0.4
Neps in ginned lint per 100 square inches of web prepared on accessory to fiber blender . . . . number	14	12	14	13

1/ Measurements made on samples from 3 replications.

2/ All lots were handled through a tower drier (no heat), 13 cylinders of cleaning, extractor feeder, 80-saw gin, and saw-type lint cleaner. The control lots received no other treatment while 0.2 percent antistatic agent (based on lint weight) was applied to the seed cotton in the treated lots.

Table 4. Effects on the mill processing performance of cotton to which an antistatic agent (Avcosol-20) was applied during ginning.[1]

Measurement	Control[2]	Treated[2]
Manufacturing waste:		
Picker and card . . . . percent	7.82	7.80
Comber . . . . percent	14.82	15.21
Neps per 100 square inches of card web . number	12	13
Yarn skein strength, grey:		
22s combed . . . . pounds	151	152
50s combed . . . . pounds	53	54
Average break factor	3,002	3,019
Yarn skein strength, mercerized:		
50s combed . . . . pounds	54	55
Break factor	2,718	2,740
Average yarn appearance:		
Combed 22s and 50s . . . . grade	C+	C+
Color of 50s combed yarn:[3]		
Grey, reflectance . . . . Rd.	76.8	76.8
Grey, yellowness . . . . +b	10.6	10.9
Dyed from grey, reflectance . . . . Rd.	25.1	25.0
Dyed from grey, blueness . . . . -b	23.0	23.0
Bleached, reflectance . . . . Rd.	84.8	84.9
Bleached, yellowness . . . . -b	3.4	3.4
Luster of 50s combed yarn:[4]		
Grey . . . . percent	33.3	32.8
Mercerized . . . . percent	42.3	41.5

1/ Measurements made on samples from 2 of 3 replications.

2/ All lots were handled through a tower drier (no heat), 13 cylinders of cleaning, extractor feeder, 80-saw gin, and saw type lint cleaner. The control lots received no other treatment while 0.2 percent antistatic agent (based on lint weight) was applied to the seed cotton in the treated lots.

3/ Color measured with a Gardner Automatic Color-Difference Meter.

4/ Measured with a Hunterlab Cotton Lustermeter.

FIELD EVALUATION

Cooperative arrangements were made with two gins in New Mexico to use the antistatic agent Tween-20 when and if static electricity became a problem during ginning in the 1957 crop season. The generation and retention of static electricity on cotton fibers are related to the electrical conductivity of the fibers, and the conductivity of raw untreated cotton depends primarily on the moisture content and temperature of the cotton. The moisture content in the absence of artifical conditioning depends on the air relative humidity.

The weather during the 1957 season was damp enough to eliminate static problems at the two cooperating gins except for two minor incidents. The antistatic agent was used once at each gin. It was applied to the cotton from one trailer at one gin, and the ginner reported that it worked satisfactorily. The material was used on approximately 50 consecutive bales at the other gin until a rain shower occurred which eliminated further difficulties due to static electricity. No samples or measurements were obtained either time.

A third cotton gin located in the Texas High Plains entered into the cooperative work for the 1958 season. Again in 1958 moist weather conditions prevailed during the ginning season, and the antistatic agent was employed only a few times. The gin in the High Plains area had light static conditions on several occasions, and the application of the antistatic solution stopped the static completely.

Equipment and Procedures To assure obtaining samples of high grade cotton treated and not treated with the antistatic agent for evaluating its effects on classification, fiber properties, and spinning and finishing characteristics, samples were taken at one of the cooperating gins in New Mexico on November 6, 1958, even though there was no static problem. The samples were taken from the cotton ginned from four multibale trailers of commercially produced Acala 1517 variety. After ginning had started on a trailer, 15 pounds of lint that would have been part of the bale was taken from the lint slide for evaluation. Then on the next bale from the same trailer, the spray system was turned on and a 15-pound sample was taken. The two samples, one treated by applying 0.1 percent Tween-20 to the seed cotton based on lint weight and one not treated (control), constituted a replication. This was repeated four times with trailers about one to one and one-half hours apart. Three quart cans of lint per bale were taken from the lint slide concurrently with the 15-pound lint samples for moisture determinations. Portions of the 15-pound samples were used for classification, nonlint determinations, and fiber analysis, and the remaining lint was shipped to the Clemson Cotton Laboratory[6/] Clemson, South Carolina, for spinning and chemical-finishing tests.

6/ ibid footnote 5/

The solution used at all three gins were approximately 25 percent Tween-20 (by volume) in tap water. They were prepared by mixing one part Tween-20 with three parts water. The spray rate at each gin was adjusted to apply approximately 0.1 percent Tween-20 to the seed cotton based on lint weight and was calculated using the average hourly capacity of the ginning plant.

A single spray nozzle mounted on the top side of a horizontal section of seed cotton handling pipe was used to spray the solution down onto the passing seed cotton in all three installations. An air pressure type spray system (fig. 3) was used in one gin, and liquid pump systems were used in the other two.

Figure 3. Commercial liquid pump spray system used to spray a mixture of Tween-20 antistatic agent and tapwater on seed cotton in the wagon suction line of a cotton gin. The left-hand vertical tubing connects to the spray nozzle and the other connects the wagon suction pipe to a pressure-sensitive switch that turns the spray off if the wagon suction air is cut off.

The solution was applied to the seed cotton ahead of all cleaning to evaluate its effects on cleaning efficiency. However, the advantages of applying the agent to the cotton at a location well along in the seed cotton cleaning system but ahead of the first location where trouble due to static is expected are: Less active agent is lost to trash, less effect on seed cotton cleaning, and the opportunity to apply the solution to a more uniform flow of cotton.

Results The results of the measurements made on the four sets of samples taken for evaluating any effects the antistatic agent might have on cotton treated with it are given in table 5. There was a slight increase in non-lint content in the treated samples, but the average government classer's grade for both treated and nontreated samples was Strict Middling minus with an average staple length of 1-5/32 inches. There were slight changes in fiber properties of Fibrograph length, tensile strength, Micronaire, and color that could possible be attributed to the antistatic agent.

There were no statistically significant changes in the spinning or chemical-finishing results between the treated and nontreated samples at the 10 percent level or less. These results are in agreement with those obtained from the 1957 laboratory evaluation tests.

On the few occasions during the 1957 and 1958 seasons that the cooperating gins used the Tween-20, it was effective, but it has not been tested under severe static conditions at a commercial gin.

ROLLER GINNING

The generation of static electricity on lint passing between the stationary knife and the roll during ginning is a problem peculiar to the roller gin. The electrostatically charged lint tends to stick to the ginning roll, causing a stoppage unless the lint is naturally moist or is artificially moistened to reduce the static, or unless positive doffing is undertaken.

Two exploratory experiments were made in the laboratory in January 1959 with American-Egyptian-type cotton to determine the effectiveness of Tween-20 for controlling static during roller ginning.

The first exploratory experiment in roller ginning consisted of applying the antistatic agent to the seed cotton by spraying. The percentage of Tween-20 based on lint weight required for static control was three or more times the amount required for static control in saw ginning operations. Even with 0.36-percent agent applied, occasional tufts of lint came through the gin with enough static charge to cling to the roll. Therefore, it would not be practical to use the antistatic agent Tween-20 for static control in roller ginning by applying it to the seed cotton.

Table 5. Average values for 4 replications of moisture and nonlint contents, classification, fiber properties, and spinning and chemical-finishing measurements on samples of Acala 1517 variety cotton not treated and treated with an antistatic agent (Tween-20) at a commercial gin.

Measurement	Control[1]	Treated[1]
LINT QUALITIES (LINT SLIDE SAMPLES)		
Moisture contents . . . . percent . .	5.31	5.60
Nonlint contents . . . . percent . .	1.65	1.93
Classification:		
Grade . . . . designation . .	[2]SM-	[2]SM-
Staple length . . . . inches . .	1-5/32	1-5/32
Color:[3]		
Reflectance . . . . Rd.	81.1	80.5
Yellowness . . . . +b	7.9	7.8
Fiber length (Fibrograph):		
Upper half mean . . . . inches . .	1.17	1.18
Mean . . . . inches . .	0.92	0.94
Uniformity . . . . ratio . .	79	80
Fiber tensile strength (Pressley):		
1/8-inch gage . . . . index . . .	115	114
Fiber fineness (Micronaire). . . .reading . . .	3.8	4.0
Sugar content . . . . percent . . .	0.2	0.2
Acid-alkaline value . . . . pH . . .	6.8	6.8
Neps in ginned lint per 100 square inches of web . . . . number . . .	14	14
PROCESSING RESULTS		
Manufacturing waste:		
Picker and card . . . . percent . . .	7.6	8.1
Comber . . . . percent . . .	12.1	12.0
Neps per 100 square inches of card web . number	13	13
Yarn skein strength, grey:		
22s combed . . . . pounds	150	152
50s combed . . . . pounds	54	53
Average break factor	2,997	3,007

See footnotes at end of table.

Table 5(continued)

Measurement	Control[1/]	Treated[1/]
Average yarn appearance:		
22s and 50s combed . . . . grade . .	B	B
Color of 50s combed yarn:[4/]		
Grey, reflectance . . . . Rd.	76.8	76.7
Grey, yellowness . . . . +b .	10.8	11.0
Color index, grey . . . . I.	106	106
Dyed from grey, reflectance . . . . Rd.	24.6	24.4
Dyed from grey, blueness . . . . -b .	23.4	23.4
Dyed after bleaching, reflectance . . . . Rd.	26.8	26.8
Dyed after bleaching, blueness . . . . -b .	27.4	27.8
Color index, dyed after bleaching . . . . I.	110	112
Luster of 50s combed yarns:[5/]		
Grey . . . . percent .	33.5	33.6

1/ All lots were handled through a feed control unit, trough drier, 14 cylinders of cleaning, extractor feeders, 90-saw gins, and unit saw-type lint cleaners. The control lots received no other treatment while 0.1 percent (by weight) Tween-20 antistatic agent was applied to the treated lots. The agent was applied by spraying a solution of one part agent and three parts tapwater on the seed cotton in the wagon suction line.

2/ SM- = Strict Middling minus.

3/ Color measured with a Nickerson-Hunter Cotton Colorimeter after samples had been cleaned in a Shirley Analyzer.

4/ Color measured with a Gardner Automatic Color-Difference Meter.

5/ Luster; measured with a Hunterlab Cotton Lustermeter.

In the second exploratory experiment undiluted Tween-20 was swabbed directly on one-half of the length of a standard 60-inch gin roll. The roll was allowed to stand overnight and then checked for possible swelling and deterioration. Neither was detected. Over a 4-day period a total of 1,122 pounds of Pima S1 variety cotton was ginned on the roll with a total ginning time of 3 hours, 18 minutes. No trouble due to static was encountered throughout the period on the treated half of the roll, but the untreated half had to be swabbed regularly with wet cloths to prevent the lint from wrapping onto the roll. How long the treatment would remain effective is unknown, as the supply of cotton was exhausted.

During the ginning on the roll with the treated section, lint samples were collected for classification. At two different times one sample was taken from the treated half of the roll and one from the untreated half. The results were:

Treatment	Composite grade	Classer's staple length
		Inches
From treated section	5+	1-3/8
From treated section	4	1-3/8
From untreated section	5+	1-3/8
From untreated section	4	1-3/8

There were no apparent bad effects produced by the antistatic agent.

Several commercial roller gins in the El Paso Valley of Texas and the Mesilla Valley of New Mexico began the use of an antistatic agent on the rolls in gins at or soon after the beginning of the 1959 ginning season. A mixture of 1 to 2 parts water and 1 part Tween-20 was applied to the rollers manually with a brush. Ginners reported satisfactory operations with the antistatic agent and that its use eliminated the need of steam for static control. The frequency of application was determined by static conditions, but some ginners reported using 2 applications per day of approximately 1 gallon of Tween-20 per 100 bales of cotton.

SUMMARY

Results of tests made in the Southwestern Cotton Ginning Research Laboratory, Mesilla Park, N. Mex., and in commercial gins in that area show that static electricity can be controlled during saw ginning with antistatic agents. Tween-20 one of these chemicals, applied in a spray at the rates of 0.2 and 0.1 percent by lint weight to seed cotton before cleaning and extracting gave satisfactory control during saw ginning of Upland Cotton (Acala 1517). No ill effects appeared in ginning. Fiber qualities, spinning, and chemical-finishing results were found not to be affected as measured by standard current research techniques.

The agent Tween-20 was tested for controlling static in a roller gin by two methods: First, by application to seed cotton similar to its use in saw-ginning operations; second, by application to the roller gin roll. The first method was unsatisfactory. The second worked satisfactorily in laboratory test and was successfully used during the ginning season in commercial roller gins in the El Paso Valley, Tex., and the Mesilla Valley, N. Mex.